authorities on which Dupuis founds his statement, but I have no doubt that it is amply justified, for the reason that doubtless all the inscriptions in the deepest tombs were made by means of reflected sunlight, for in all freshly-opened tombs there are no traces whatever of any kind of combustion having taken place even in the innermost recesses. So strikingly evident is this that my friend M. Bouriant, while we were discussing this matter at Thebes, laughingly suggested the possibility that the electric light was known to the ancient Egyptians.

With a system of fixed mirrors inside the galleries, whatever their length, and a movable mirror outside to follow the course of an Egyptian sun and reflect its beams inside, it would be possible to keep up a constant illumination in any part of the galleries, however remote.

Dupuis quotes another statement that the greatest precautions were taken that the first rays of sunlight should enter a temple (of course he means a solar temple).

J. NORMAN LOCKYER.

(*To be continued.*)

ON THE NUMBER OF DUST PARTICLES IN THE ATMOSPHERE OF VARIOUS PLACES IN GREAT BRITAIN AND ON THE CONTINENT, WITH REMARKS ON THE RELATION BETWEEN THE AMOUNT OF DUST AND METEOROLOGICAL PHENOMENA.—Part II.[1]

THIS paper contains the results of the observations made on the dust of the atmosphere at various places in 1890. These observations were made by the author at the same stations, and about the same dates, as those made in 1889, and given in Part I. of this subject, read before the Society on February 3, 1890.

At Hyères, in 1890, the highest number of dust particles observed was 15,000 per c.c., with a wet bulb depression of 5°, the atmosphere at the time being very thick. The lowest was 725 per c.c., with a wet bulb depression of 9°·5, when the air was very clear.

At Cannes very few observations were made on this occasion. The numbers varied from 1275 to 2850 per c.c. The wind during the time was always northerly.

At Mentone the numbers varied from 26,000 per c.c. when the wind was from the town, to about 900 per c.c. when it was from the mountains, with a wet bulb depression on both occasions of 3½°; the air was clear with the lower number and thick with the higher.

At Bellagio, when the wind was southerly—that is, from the inhabited districts—the number of particles was great, on one occasion as high as 20,000 per c.c. But when the wind blew from the north—that is, from the direction of the Alps—the number fell as low as 600 per c.c. on one occasion. With the low numbers the air was clear, whereas with the high numbers there was always a good deal of haze, though the air was dry.

All the observations made at Baveno were made while the wind blew from the inhabited areas, and the air was never clear, although on some days it was very dry. The highest number observed at this station was 16,000 per c.c., and the lowest 2000 per c.c.

The observations made at the Rigi Kulm from May 15 to 20 are then discussed. There was a marked difference in the appearance of the air on this occasion compared with what was seen on the first visit. During the previous visit the weather was generally fine, and the air had that crisp clearness which gives the hard outline and crude colouring one generally associates with Swiss scenery; whereas on the second visit the air was remarkably thick and heavy.

The highest number observed on the first visit to the Rigi was not much over 2000 per c.c., while the number was as high as 10,000 on the second. The same relative condition of impurity existed at the low level also. On the first occasion the number at the level of the lake varied from 600 to 3000 per c.c., whereas on the second visit they varied from 1700 to 13,000 per c.c. Roughly speaking, there was about four times the amount of dust in 1890 there was in 1889, and the air was about four times as thick.

On the way up the Rigi the air was tested at the level of the lake and found to have about 11,000 particles per c.c. There was a very thick haze at the time, through which the mountains loomed darkly. This thickness was evidently not due to humidity, as the wet bulb showed a depression of 10 degrees. This very thick haze was therefore due to fairly dry particles of dust. On arriving at the top of the mountain in the afternoon, the air was tested and found to have slightly over 4000 particles per c.c.

During the first four days of the second visit to the Rigi Kulm the air was very thick and the number of particles great. The much greater thickness of the air on the occasion of the second visit was evidently due to dust, as the humidity on both occasions was about the same. The air on the days when the number of particles was great was very different from anything previously observed at this station. On the first visit the air was clear and bright, with only a thin haze between the observer and the distant mountains; whereas in 1890 a dense haze hung in the atmosphere, so thick that towards sunset the lower slopes of Pilatus could scarcely be distinguished. It looked as if a veil had been hung up between the observer and the distant scenery. Some time before sunset this hazy veil became coloured by the rays of the setting sun. Its upper limit was well defined in the eastern sky, at an elevation considerably above the highest of the Alps. At sunset this dusty impurity became still more apparent as the earth's shadow crept up its lower edge. Though the sky was cloudless, so dull was the setting sun, that it looked more like a harvest moon than the orb of day. So feeble were its rays after penetrating the thick haze, that they could produce no direct red light on the mountains, while much diffused light was reflected by the dust-laden air.

During this second visit there was an opportunity of testing the supposed influence of thunderstorms in depositing the dust in the atmosphere. On one of the days of this visit a violent thunderstorm raged to the east, south, and west during most of the afternoon, and in the evening it came over the Rigi Kulm. So near was the storm that the flash and crash of the thunder seemed simultaneous. The tests were therefore made in the very air in which the lightning discharges were taking place. During the day, and before the storm approached, there were nearly 4000 particles per c.c. in the air. At 6 p.m., when the storm was near, the number fell to 3000; and at 7.10 p.m., when the storm was nearly over, the number was as low as 725 per c.c. These figures seem to support the supposition that thunderstorms purify the air; and if anyone who was a believer in the purifying influence of these storms had been on the top of the mountain next day, his opinion would have been confirmed by the greatly improved appearance of the atmosphere after the storm. The thick veil which had hung in the atmosphere for at least four days was gone, and the distant mountains looked clear and distinct. Even Hochgerrach, which is about 70 miles distant, was quite distinctly seen during the whole day; and the number of particles fell to 400 per c.c.

The question—Was the decrease in the dust, and the improved appearance of the atmosphere on this occasion due to the thunderstorm?—is then discussed. It is shown that this conclusion is extremely doubtful. It is pointed out that the violent down-rush of air produced by a heavy hail-shower at the time would bring down the purer upper air to the place of observation, so that the air tested at 7.10 p.m. was not the same as that tested previously, but was air from a higher and purer stratum. The purifying influence of the down-rush of air in this case was not nearly so great as was observed in the heavy rainfall on the Eiffel Tower recorded in Part I.

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[1] Abstract of a Paper read before the Royal Society of Edinburgh on January 4, by John Aitken, F.R.S. Communicated by permission of the Council of the Society

By midday of the last day of the visit to the Rigi Kulm, the air again became very much hazed, and the number of particles rose to about 10,000 per c.c. On descending the mountain, the air was again tested on this day, at the level of the lake, at 3 p.m. Here the number was a little over 10,000, or very much the same as it was when tested on the way up. Its humidity was also the same, and it had the same thick appearance.

Just when on the point of finishing the tests at the level of the lake, it was observed that the numbers were becoming unsteady and were falling. The tests were therefore continued for a considerable time longer, when it was found that the dust particles, which at first were 10,250 per c.c., gradually decreased to 1700 per c.c.; a most unusual experience, and one which might have shaken our confidence in the dust-counter, had it not been noticed that this decrease in the dust was at the same time accompanied by a rise in the temperature of the air, and by a decrease in its humidity. When the tests were begun, and the number of particles was great, the temperature was 71°, and the wet bulb was depressed 11 degrees; but when the amount of dust was small, the temperature had risen to 74°·5, and the wet bulb depression was as much as 18·5 degrees. These observations all show that in a very short time there had been an entire change of the air at the place of observation. This result is shown to have been produced by the local wind, which at first blew in from the lake, changing by the upper part of the current striking the nearly perpendicular face of the mountain, curving downwards, and then blowing out towards the lake, thus bringing a purer upper air to the place of observation. After a time the down-blow ceased, and the wind at the level of the lake returned to its original direction. After the wind had blown a short time off the lake, the number of particles rapidly increased, and became slightly higher than it was at first. The temperature and humidity also returned to near their original readings.

The Rigi Kulm observations show the daily maximum of dust very clearly. On all the days, except one, the number of particles was least in the morning, and increased greatly as the day advanced, owing to the ascent of valley air on the sun-heated slopes of the mountain. The impure air had generally arrived at the mountain top before midday, and by midday the number was generally three times greater than it was in the morning.

Observations were also made on one day on Pilatus Kulm. During the whole day the mountain was covered with cloud. On this occasion the numbers were found to be very unsteady, varying greatly in short intervals. The highest reading was 1275 per c.c., and lowest 625 per c.c.

The result of an investigation into the cause of the difference observed in the air of Switzerland on the two occasions is then given. It is shown that during the days of the first visit the upper air circulation was generally from the south, and was pure, as it came from the uninhabited area of the Alps; while during the first days of the second visit the general air circulation was northerly—that is, from densely inhabited and polluted areas. While this northerly circulation continued, the air was thickly hazed, and the number of particles was great. On the morning of the day of the thunderstorm already referred to, the wind had changed and begun to blow freshly from the south, at the St. Gothard. It had also changed to south on the Säntis and Rigi. But though the wind had begun to blow from a pure direction in the morning, it was evening before the pure air arrived at the Rigi. It was at the meeting area of the lower impure northerly air with the upper pure southerly that the thunderstorm took place. The storm began to the south, where the currents first met, and travelled northwards as the pure south wind drove the northerly air before it. The sudden drop in the number of dust particles in the storm may therefore possibly have been due to the arrival of the pure southerly air.

The day after the storm the southerly wind continued to blow, the air became very clear, and the number of particles fell practically as low as was observed on the previous visit, while the air had much the same clear appearance it had on that occasion. It would thus seem that the clearing of the atmosphere on this occasion, though at first sight it may have appeared to have been caused by the thunderstorm, was in reality caused by a change in the circulation of the air. The clearing would thus appear to have been due, not to a clearing of the dust out of the air, but to a change of the air itself.

The observations made on Ben Nevis and at Kingairloch, for July 1890, are then discussed, and a comparison made of the variations in the amount of dust at high and low levels. The observations made at Kingairloch in 1890 confirm the conclusions arrived at in Part I., that the air at this station has most dust in it when the wind blows from the east, south-east, and south—that is, from inhabited areas—and less when the wind blows northerly—that is, from uninhabited areas. Some very remarkable exceptions to the latter conclusion were, however, observed. On a number of days when the wind was northerly the number of particles rose high at some hour of the day. On examining into the cause of the exceptional readings with northerly winds, it was found that they almost always occurred when the isobars over our area were irregular and the general circulation in a confused condition, and blowing in different directions at different stations at no great distances from each other. It is suggested that under these conditions uniformity in the air cannot be expected; that, while testing in a northerly wind, it may be southerly air that is being examined. In confirmation of this it is shown that whenever the general air circulation over our area was mixed and irregular, high numbers were also observed at some time of the day on Ben Nevis.

An examination of the numbers of dust particles shows that there was much less dust in 1890 than in 1889. The numbers in 1890 fell very low on many days, and extremely low on a few days. The lowest number observed was 16·5 per c.c. This number is much lower than any previously observed at any low-level station. Associated with the small amount of dust was an exceptionally low temperature. July of 1890 will long be remembered as one of the most inclement experienced for many years, being cold, wet, and windy.

A comparison is made of the amount of dust at Kingairloch and Ben Nevis. Although there is a considerable resemblance between the figures at the two stations, yet the likeness is not very close. This is owing to the daily maximum of dust which takes place at high levels on most days; also to the effect of the wind on the amount of dust not being the same at high and low levels; and further, the directions of the winds are not always the same at both stations. As a rule, there was much less dust at the high station than at the low one, and when the dust increased at the low station it also generally increased at the high one, and *vice versâ*. These rules, however, are not without exceptions. Sometimes the lower air was purer than the upper; this happened when the wind blew from a pure direction low down, while it was from the east or south on the Ben. Mr. Rankin has shown, from an extensive series of observations at the Observatory, that the south, south-east, and east winds bring the most impure air to the Ben—a conclusion in keeping with the result obtained at low level.

It is concluded from the observations that high winds reduce the transparency of the air. In Part I. this conclusion is indicated, and the observations of 1890 confirm it. It is pointed out that whenever the wind was high, the air was unduly thick for the number of particles and the humidity. This is thought to be due to high winds carrying large particles, and mixing the lower stratum of impure air with the purer upper air. The inequalities in the density of the different parts of the air produced by imperfect mixing will also reduce its transparency.

The Alford observations for 1890 show that the air was occasionally purer and the maximum a little higher in that year than on the previous visit. Whenever the wind blew from the south, it brought polluted air to this station, as it came from inhabited areas; and when the wind was northerly the air was pure. The number of particles was as low as 127 per c.c. with a north-west wind, while it was as high as 6800 per c.c. with a south wind.

An ascent of Callievar was made in 1890 also. On the first visit the air was clear, and the Cairngorms and Lochnagar were clearly seen. The number of particles was 262 per c.c., and rose in the afternoon to 475 per c.c.; but on the second visit the air was thick, and only a faint outline of the Cairngorms was occasionally seen, while Lochnagar was quite invisible. The number of particles was 710, and rose in the afternoon to 1575 per c.c.

The air on this occasion was very irregularly hazed, not being equally transparent in all directions. One mass of air darkened the view to the west, passed over the hill-top and darkened the view to the east. Before this impure mass of air arrived at the hill-top the number of particles was 710, while it was passing the number rose to 1575, and after it had gone east the number fell to 1050 per c.c. During these observations the humidity remained constant. The variations in the transparency were therefore due to variations in the amount of dust.

The condition of the air during the exceptionally warm February of 1890 was tested at Garelochhead on the 27th of the month. Previous to that date the weather had been very warm, temperatures of 50° and 60° having been frequently recorded in our area, and even 64° was observed in more places than one. The result of the tests showed the air to be remarkably full of dust. During the visit to this station in the end of January 1889, the maximum number of particles observed was 2360, and that was the only occasion on which it was over 1000; whilst on the first day of the second visit the smallest number observed was 7250, and other readings gave nearly 10,000. During this warm period the air was always impure, and had much the same appearance as it had on the 27th. The cause of this great amount of impurity was the presence of an anticyclone lying over Europe, giving rise to southerly winds over our area. The local winds were, however, very light and mixed, and there was no general circulation of the air; the dust impurities therefore accumulated, and, as the figures show, became very great. On the 28th, the day after the air was tested, a depression appeared off the north of our islands, and the isobars were closing in and westerly winds were beginning to blow. With this change the dust began to fall, and was as low as 1750 per c.c. on the 28th. On March 1 and 2 the isobars closed in still further, the winds freshened, and the dust fell to 51 per c.c., or $\frac{1}{200}$ of what it was on February 27. During the 3rd, 4th, and 5th, the wind remained in the north-west, and the amount of dust was very small.

Certain relations between isobars and dust are pointed out. With regular isobars for westerly and northerly winds the air is pure, and the closer the isobars the purer is the air; whilst isobars for southerly or easterly winds, even though close, do not indicate pure air. From these facts it is shown that an estimate of the amount of dust on any day can be made from an examination of the weather charts made on and previous to the day selected.

The relation between the amount of dust and the temperature is discussed, with the view of finding whether the observations made in 1890 confirm the conclusion arrived at from the previous records. That conclusion was that a great amount of dust increases the day temperature and checks the fall of temperature at night. The records of temperature and radiation made at Kingairloch in 1890 are of no value, owing to the weather being always under the influence of cyclones, so that there was an absence of clear skies, and the temperatures were regulated by what the winds brought, and were but little influenced by local conditions. But, as already stated, the dust at this station was exceedingly low in 1890, and the temperature was also exceptionally low.

The Alford observations, however, are not open to the same defect, as the weather was suitable for the purpose. These observations point to the same conclusion as that arrived at in 1889. The highest maximum temperatures were recorded on days of high dust, and the lowest minimum when the dust was at a minimum.

The observations made at Garelochhead also support the same conclusion. Towards the end of February the amount of dust was great, and from the meteorological report it will be seen that the temperature was above the mean, and was frequently very high. Again, when the westerly winds swept away the great impurity, they brought with them a high mean temperature. But after the winds ceased to blow, the pure air brought to our area by them seems to have allowed radiation to act freely, as the air then rapidly cooled, and the temperature became exceedingly low, as much as from 8 to 11 degrees below the mean in some stations in Scotland. The Ben Nevis observations show that during this exceptionally cold period the air was remarkably free from dust.

JOHN COUCH ADAMS

It is with deep regret that we record the death of Prof. Adams, who will always hold an eminent place in the history of astronomical science. As he is included in the list of our "Scientific Worthies," we have already given an account of his career (vol. xxxiv. p. 565). It is only necessary for us now, therefore—as in the case of Sir George Airy—to note some of the leading facts of his life and work.

He was born at Lidcot, near Launceston, in Cornwall, on June 5, 1819. He received his early education at the village school and at Devonport, where he gave evidence of his remarkable faculty for mathematical and astronomical study. In October 1839, he entered at St. John's College, Cambridge; and in 1843 he graduated as Senior Wrangler and first Smith's Prizeman, becoming shortly afterwards a Fellow and tutor of his College.

Both before and after taking his degree he was fascinated by a problem which was at that time profoundly interesting astronomers—the irregularities shown by the planet Uranus in its motion. Its orbit differed from the elliptic path which an undisturbed planet would have pursued; and as the deviations could not be explained by the influence of the other known planets, it was supposed that there must be a more remote planet which had not then been observed. To the search for this unknown planet Adams devoted all the energies of his mathematical genius, and everyone knows the brilliant success with which his labours were crowned. His solution was communicated to Prof. Challis in September 1845, and to the Astronomer-Royal in the following month. We need only refer to the facts that similar work was done in 1846 by Leverrier; that the French astronomer's results, unlike those of the English investi-